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# Qualitative Arms Control: The Case of Laser Weapons

George R. Mastroianni



Division of Ocular Hazards Research

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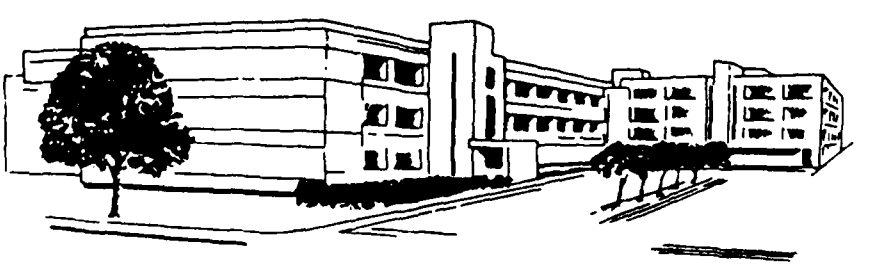

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Qualitative Arms Control: The Case of Laser Weapons, Inst Rpt 454, G.R. Mastroianni

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Governmental entities have negotiated and entered into arms control agreements since medieval times. One type of arms control agreement limits the possession or use of specific kinds of weapons. Such agreements are called qualitative arms control, to distinguish them from agreements placing numerical limits on arsenals, the more common quantitative arms control. This paper examines the history of qualitative arms control in the twentieth century, and discusses some theoretical analyses of the conditions necessary for successful arms control negotiations.

The case of laser weapons, which are emerging as a matter of international concern, is discussed in light of the general principles that arise from consideration of the theoretical issues in arms control. Of particular concern are the need for mutual interest in reaching agreement among the parties to arms control negotiations, and the achievement of rough parity among adversaries in overall power. The achievement of international control of laser weapons is not likely to succeed soon, because the conditions necessary for effective negotiation have not been met. Keywords: Balance of power; International law; Laser targets. (MM)


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## ABSTRACT

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The case of laser weapons, which are emerging as a matter of international concern, is discussed in light of the general principles that arise from consideration of the theoretical issues in arms control. Of particular concern are the need for mutual interest in reaching agreement among the parties to arms control negotiations, and the achievement of rough parity among adversaries in overall power. The achievement of international control of laser weapons is not likely to succeed soon, because the conditions necessary for effective negotiation have not been met.


## PREFACE

This paper was written while the author was a graduate student in International Relations at San Francisco State University. Because his work at Letterman Army Institute of Research involved the US Army laser protection program and brought the author into contact with a wealth of material relating to the international aspects of tactical laser warfare, it seemed quite natural to incorporate this material into his studies at SFSU. Once this paper was completed and submitted to the University, it seemed that it might be of interest to others in the military community who are concerned with the problems that arise as laser warfare evolves. The publication of this Institute Report is intended to make this paper easily available to the military laser community.

The opinions expressed in this paper do not represent the official position of the Letterman Army Institute of Research, the Army Medical Research and Development Command, or the US Army; they are solely the personal views of the author. This paper benefitted from the critical reading of Mr. Bruce Stuck, Mr. Hayes Parks and Dr. DeVere Petony (SFSU). Defects remain the responsibility of the author.

**Qualitative Arms Control: The Case of Laser Weapons**--George R. Mastroianni

It has been recognized for centuries that there are benefits to managing competition in the creation and production of arms. Efforts to restrict and reduce weapons as well as war-making capacity with the purpose of enhancing security and diminishing the economic burden of participating in arms races date at least to medieval times (1). While contemporary arms control efforts take many forms, those which grow from the tradition of attempts to control specific weapons, frequently those considered especially inhumane or barbaric, have received considerable attention lately.

The best-known current example of this tradition is the campaign to prohibit the production and use of chemical weapons. These efforts received considerable publicity amid accusations that chemical weapons had been used extensively in the Iran-Iraq war. International pressure to control chemical weapons has been consistent since the First World War; recent efforts are not a new phenomenon, but represent an attempt to strengthen a consensus perceived to be eroding.

The case of chemical weapons is an example of the sort of arms control termed by some as qualitative arms control. This name implies that the intended control will apply categorically to all weapons of a particular kind. Another kind of weapon that has received some attention in the news recently is laser weapons. While we have no experience with widespread use of lasers in combat, there is a growing series of news reports that indicate a significant and increasing reliance of modern military establishments on weapons using lasers, and perhaps laser weapons. Partly as a result of this trend, some international efforts to conclude a qualitative arms control agreement regulating the use of lasers in combat have been undertaken. The balance of this article will be devoted to reviewing the history of qualitative arms control in this century, and analyzing the prospects for the conclusion of an agreement regulating the use of lasers in combat.

The first agreement regulating or prohibiting specific types of weapons deemed to be "inhumane" in modern history is the St. Petersburg Declaration of 1868 (1). A non-binding declaration with 19 signatories, this agreement is remembered more for the general principles it established than for the contribution of the specific prohibitions suggested. The specific prohibition against exploding projectiles weighing less than 400 grams probably had little impact of itself. The principles which formed the basis for this specific prohibition, however, still represent the clearest statement of the aims which motivate efforts to control specific, "inhumane" weapons. These principles are reproduced below:

> That the only legitimate object which states should endeavour to accomplish during war is to weaken the military force of the enemy;
>
> That for this purpose, it is sufficient to disable the greatest possible number of men;
>
> That this object would be exceeded by the employment of arms which uselessly aggravate the sufferings of disabled men, or render their death inevitable;

> That the employment of such arms would, therefore, be contrary to the laws of humanity (Declaration of St. Petersburg, signed 11 December 1868)

Another example of arms control following these principles is found in the Hague Conventions of 1899 and 1907. The 1899 Convention, Article 23 (e) states that it is prohibited to:

> "employ arms projectiles or material of a nature to cause superfluous injury" (1)

The 1907 Convention changes this sentence to read:

> "...employ arms, projectiles or material calculated to cause unnecessary suffering" (1)

Protocol I to the 1949 Geneva Convention, signed in 1977, puts it this way:

> "It is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering" (2)

Specific prohibitions contained in the various Declarations to the 1899 Convention prohibited the use of balloons as bombing platforms, the use of projectiles charged with poison gas, and the use of so-called "Dum-Dum" bullets. The 1907 Convention added automatic submarine mines.

The specific prohibition against Dum-Dum bullets was aimed directly at the British, and at least one writer (3) argues that the motivation for the campaign to include this provision had more to do with an opportunistic attempt to embarrass a dominant world power than with any genuine desire to prevent or mitigate suffering.

The 1925 Geneva Protocol prohibiting the use of poison gas represents a major milestone in qualitative arms control. The revulsion caused by the use of chemical weapons in WW I stimulated the parties to the protocol to enter into the agreement. That chemical weapons were not used by any signatories to the Protocol even during the most desperate days of WW II is testimony to the power of this hideous legacy--some think that Hitler's personal experience with gas was responsible for his refusal to authorize the use of Germany's large stock of nerve gas.

The most recent agreement regulating specific, inhumane weapons is the 1981 United Nations Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which may be Deemed to be Excessively Injurious or to Have Indiscriminate Effects (2). The objects of this agreement were fragmentation weapons producing fragments undetectable by X-ray, mines, booby-traps and incendiary weapons. The agreement is mainly aimed at protecting civilians.

Paul Diehl has outlined five conditions which must exist before arms control efforts are likely to succeed. These are:

1. The parties must have a common interest in and desire for peace.

2. There must be trust between the parties and/or assurance of compliance.

3. Public opinion and allied pressure must promote the agreement.

4. The domestic political climate must be favorable.

5. The diplomatic climate must be favorable. (4)

While this framework does not cover every aspect of the politics of arms races (for example, the economic benefits and penalties of arms production and import/export are perhaps significant enough to deserve separate mention) it offers a convenient and incisive checklist against which specific conditions can be compared to gauge the chances of a particular arms control effort.

In discussing the need for a mutual interest in achieving arms control, Diehl points out that perceived disparity can contribute to the difficulty in reaching an agreement. When one party possesses an advantage, there are difficulties on both sides in moving toward a condition of parity. The side with an advantage will feel disinclined to bargain it away without extracting maximum concessions from the other side, while the disadvantaged side will be reluctant to be seen compromising in the face of superior power.

The issue of parity is particularly important when considering qualitative arms control for two reasons. First, as the scope of arms control efforts narrows, the likelihood of disparity increases. Countries invest their defense budgets in a variety of armaments that meet the particular security demands they face. For geostrategic, political, and economic-technical reasons, adversaries often have very different defense establishments. The Warsaw Pact relies heavily on large numbers of tanks and artillery, for example, while NATO appears to have the edge in sophisticated aircraft. Qualitative arms control, focusing as it does on a particular weapon or class of weapons, may concentrate on an unbalanced element in an overall defense posture that is roughly balanced.

A second reason that parity is so significant in qualitative arms control is that weapons singled out for such efforts are often the newest weapons. New weapons are often produced by leading industrial powers, causing a built-in disparity between nations with advanced technological capabilities and those with less developed technical resources. Not all new weapons are considered inhumane, but the historical record suggests that weapons are more likely to be deemed inhumane when they are new. The weapons which stimulated the provisions of the Hague Conventions relating to "unnecessary suffering", for example, were all new weapons at the time: aerial bombing, submarine mines, and chemically-charged artillery. The 1981 UN Convention addressed non-metallic fragmentation weapons, a new weapon which actually has never seen widespread use.

Recent developments have emphasized that economic and political factors may affect judgements about the humanity of a weapon independent of its novelty. Some

developing countries have recently been accused of developing chemical or biological weapons capabilities. These countries are usually in unstable regions, and are excluded from the possession of nuclear weapons both by their inability to produce them locally and the non-proliferation regimes established by the nuclear powers. Chemical and biological weapons are seen as a cheap and feasible way to achieve local superiority or even challenge more distant enemies. This tendency presages what may evolve as one of the primary post-Cold War security problems: the search for mutual interest in arms control between the developed and developing regions of the world. As the East-West confrontation fades, North-South issues will loom ever larger.

The essence of the issue of mutual interest and parity is nicely summarized by the Disarmament Fable that appeared in Churchill's 1936 book, and is well worth reproducing in its entirety:

> Once upon a time all the animals in the zoo decided that they would disarm, and they arranged to have a conference to arrange the matter. So the rhinoceros said when he opened the proceedings that the use of teeth was barbarous and horrible and ought to be strictly prohibited by general consent. Horns, which were mainly defensive weapons, would, of course, have to be allowed. The buffalo, the stag, the porcupine, and even the little hedgehog all said they would vote with the rhino, but the lion and the tiger took a different view. They defended teeth and even claws, which they described as honourable weapons of immemorial antiquity. The panther, the leopard, the puma and the whole tribe of small cats all supported the lion and the tiger. Then the bear spoke. He proposed that both teeth and horns should be banned and never used again for fighting by any animal. It would be quite enough if animals were allowed to give each other a good hug when they quarreled. No one could object to that. It was so fraternal, and it would be a great step towards peace. However, all the other animals were very offended with the bear, and the turkey fell into a perfect panic. The discussion got so hot and angry, and all those animals began thinking so much about horns and teeth and hugging when they argued about the peaceful intentions that had brought them together that they began to look at one another in a very nasty way. Luckily the keepers were able to calm them down and persuade them to go back quietly to their cages, and they began to feel quite friendly with one another again. (Churchill, 1936)

Other components of Diehl's framework also have special application when considering qualitative arms control. The novel, technologically sophisticated nature of many of the weapons that have been considered has made verification of potential agreements more problematic than is the case with familiar weapons, undermining the basis for mutual trust which must exist for arms control to be successful. The technical means necessary to detect and track these new weapons often evolve only slowly, and become an important component of the perception of parity.

The role of public opinion and allied pressure is also particularly significant when considering qualitative arms control. The very specificity of the process invites a concentration of media attention in a way that makes mobilization of public opinion easier

than in the case of more general arms control issues. The publicity and resultant controversy surrounding the introduction of so-called neutron bombs and the political fallout from the episode exemplifies the vulnerability of specific new weapons to manipulation of public opinion; the Soviets attempted to influence European public opinion in the same way on the deployment of Pershing missiles, and signed the INF accord after it became clear that American policy would not change as a result of the media campaign.

The case in which we are interested, that of laser weapons, offers a convenient framework for demonstrating the particular characteristics of qualitative arms control that distinguish such efforts from more familiar formulas. Before addressing the chain of diplomatic events that has occurred with respect to laser weapons, it will be beneficial to review briefly the nature and military uses of lasers today.

Lasers are used in a variety of applications by modern armed forces, and are expected to play a major role in any future general conflict. Lasers are optical devices that produce a highly collimated beam of narrow-band radiation. In practical terms, a laser produces a very intense beam of light of a particular wavelength that can be propagated over considerable distances while retaining sufficient energy to cause a variety of effects (5).

Lasers have been used for some time to accomplish two tasks for modern armies: rangefinding and target designation. Laser rangefinders operate by emitting a short pulse of laser energy; by measuring the time before detection of the reflected pulse, the range to the reflecting object can be calculated. Modern field armies employ hand-held laser rangefinders that are used by artillerymen to accurately measure the distance to targets; new tanks are fitted with laser rangefinders to enhance the accuracy of their fire; and modern aircraft and helicopters use laser rangefinders for weapons targeting.

Laser target designators operate on a similar principle: an operator aims a laser at a target, which reflects the energy incident from the designator. A weapon capable of detecting the reflected energy, such as a missile, bomb or artillery projectile, then guides itself to the target. The Hellfire missile and Copperhead artillery system are examples of such weapons in the American inventory, but others are found in many NATO and Warsaw Pact Armies (6).

Tens of thousands of lasers are in operational use with modern armed services today. Lasers powerful enough to accomplish the tasks for which they are suited at militarily significant ranges (up to several kilometers) can pose a hazard to personnel at these and even greater distances. The primary hazard is to the eye of someone who looks directly at a beam. Eyes are particularly vulnerable because the optics of the eye collect in-band radiation and concentrate it on the sensitive surface of the eye, the retina. Using binoculars or other optical systems increases this magnification factor still further, causing an extension of the range at which lasers can be hazardous (5).

The precise nature of the effects caused by exposure to laser radiation depends on a number of complicated technical parameters, but wavelength, intensity, and the temporal characteristics of the laser exposure are most significant. Effects on human vision can range from no effect to a brief, transitory disturbance in normal visual function lasting seconds or minutes (often called "dazzle" or "flashblindness") to permanent blindness caused by damage to the retina and hemorrhage. Most of these effects can be prevented if appropriate filters

are available and worn. These filters are similar in principle to sunglasses, screening out unwanted light. The task of supplying such filters, which are wavelength-specific, is complicated by uncertainty concerning the wavelength at which a threat laser may operate.

A more recent trend in the military use of lasers has involved applications beyond rangefinding and target designation. There has apparently been an effort to develop lasers designed specifically to produce the effects described above; that is, to operate primarily as anti-personnel or anti-sensor weapons. These devices would be used to blind soldiers or to damage electro-optical equipment in battle. Such uses have not yet been documented, but are apparently promising enough for research and some development of such weapons to have already taken place (6).

Several open-literature reports have suggested both this general trend and some specific U.S. developments. A November 1987 article in Lasers and Optronics reported that the Army had contracted for prototypes of a hand-held laser weapon; New Scientist reported in 1985 that a battlefield anti-sensor laser called Stingray was under development; and Defence News in October 1987 reported an airborne anti-sensor laser under development by the Navy and Air Force called Coronet Prince. More recently, Jane's Defence Weekly reported in January 1990 that the British Royal Navy had mounted lasers on several ships to deter attacking aircraft.

While less is known about Soviet laser developments, one estimate (Military Technology, May 1987) is that the Soviets spend 3-5 times as much on tactical battlefield lasers as the U.S. Several incidents in which U.S. pilots were apparently illuminated by a laser on a Soviet ship have been reported (Defence News, 19 Oct 87).

Sweden and Switzerland have attempted to stimulate international interest in the regulation of military use of lasers in several international forums, including the Red Cross and the UN Committee for Disarmament (6). Early proposals called for condemnation of the blinding effects of lasers, while more current formulations include recognition of the legitimate uses in range finding and designation, but seek to distinguish and proscribe purposeful anti-personnel employment of lasers that could lead to permanent disability.

In no case have the proposals to regulate lasers in military use enjoyed widespread support. No resolutions or proposals have been adopted by international organizations despite persistent efforts by a small group of neutral countries. Why has this been so, and what are the prospects for such proposals in the future?

The official U.S. position on the Swedish proposals offers the clearest statement of the objections to the proposed regulations. The U.S. position is that blinding by lasers cannot be considered to be inhumane on the basis of any existing international agreement, and that the unenthusiastic reception given the regulatory proposals by most governments validates this view (6).

Further, the U.S. questions the practicality and value of any formula which seeks to distinguish laser use on the basis of intention, prohibiting only use motivated to injure and permitting use intended to range or designate. The enforcement of a ban which would permit the blinding of a soldier riding on a tank (incidental to ranging on the tank) while

prohibiting blinding of a soldier a few feet away (purposely) would prove completely unworkable in practice (6). The burden of resolving conflicts based on so weak a principle would far outweigh any benefits gained from this minor prohibition.

The specific proposal advanced by the Swedes would create a situation in which mutual trust and assurance of compliance would be very difficult to maintain. If such trust is essential to the arms control enterprise, as Diehl suggests, then the Swedish proposal is fundamentally flawed in this respect.

The Swedish proposal also fails some other tests suggested by Diehl's framework (7). At the top of the list is the need for mutual interest. What have the various parties to gain from controlling lasers? At present, there seems little to gain and potentially much to lose. Lasers make possible a generation of "smart" weapons that may themselves reduce the burden of the arms race. If a laser-guided missile is more accurate and reliable than older models, and makes possible the same degree of security with a smaller stockpile, then whose interest is served by making it more difficult to deploy such weapons? Because of increased accuracy, smart weapons have the potential to ameliorate some of the disadvantages inherent in maintaining conventional arsenals - smaller arsenals mean (possibly) lower cost, less environmental impact from production, storage, and disposal, and less collateral and accidental damage.

The risks from the proliferation of blinding laser weapons are real, but we can only speculate as to how decisive these devices might be in battle. The Swedish proposal is unworkable, yet countries might still take steps to control lasers as weapons if the formula did not jeopardize recognized, legitimate uses of lasers. On the other hand, if countries feel that the potential advantage to them in attacking the visual sensors of the enemy with lasers outweighs their own vulnerability to the same sort of attack, they will be less inclined to make serious arms control efforts. The present situation seems to lack a sense of urgency on the part of most nations; until a consensus of concern evolves that will engender the mutual interest needed to support serious efforts, progress is unlikely.

Public opinion, also an element of Diehl's framework, is one mechanism which has the potential to stimulate greater interest in controlling laser weapons. Currently, there is no groundswell of public feeling regarding the inhumanity of laser weapons; in fact, the topic is arcane enough that there is probably very little awareness of the issue outside limited technical, diplomatic and military circles. This could all change rapidly if a large number of injuries were inflicted by lasers in some conflict. History seems to indicate that a large-scale demonstration of the effects of a weapon is helpful in spurring progress toward control. Chemical weapons were addressed by the Hague conventions, yet WW I saw widespread use of poison gas. The 1925 Geneva Protocol, which has formed the basis for the rejection of chemical weapons until recent Iraqi use, clearly derived much momentum from the memories of the war. Nuclear arms control relies heavily on the horrible destruction visited upon Hiroshima and Nagasaki to keep the issue real and important to the people of the world. In the absence of any real experience with lasers, will public pressure and momentum for control ever develop?

One encouraging exception to the pattern of arms control efforts being successful only after the destructive effects are demonstrated is the case of biological weapons. There have been no documented cases of large-scale use of biological warfare in modern history,

yet rejection of biological weapons is well institutionalized in international agreements. One might argue that the human memory of epidemics and natural biological disasters has provided a surrogate for the hostile events that have spurred control of chemical and nuclear weapons, leading to public horror at the prospect of intentionally induced plagues without the necessity for a demonstration. Whatever the reason, the existence of consensus on biological weapons should persuade us that control of laser weapons, if desirable, need not necessarily await the next conflict.

If control of laser weapons were ever to become urgent enough to merit serious efforts at forging an agreement, how could the technical obstacles raised by the U.S. in response to the Swedish/Swiss proposals be overcome? One formula that might have promise would be restriction of
the portions of the electromagnetic spectrum in which laser emissions are permitted. Technology is incapable of determining the intention with which a laser is fired; no conceivable technical development will make such determinations possible. It is quite possible, however, with existing or near-term capabilities to precisely characterize the wavelength, intensity and duration of laser energy emitted on a battlefield. "Laser free zones" in the electromagnetic spectrum could provide adequate opportunity for all legitimate laser uses, while simultaneously providing adequate information to allow effective protective measures to be taken. The verification task would simply be to detect any laser use outside the agreed-upon wavelengths. The result would be objective, quantitative evidence that could serve as a basis for resolving conflicts.

As the Cold War evolves into a new security regime in Europe, and as arms control outside the superpower relationship becomes more important, the arms control process will provide one of the main bridges to the future. The agreements that will implement the promised reductions in Europe and regulate the growth of arsenals elsewhere in the world will likely include a wide variety of mechanisms and formulas. Quantitative, qualitative, and hybrid agreements, confidence- and confidence and security-building measures will be applied to quantities and types of weapons thought untouchable when tensions were higher.

The conversion of goodwill into better security will demand flexibility and insight from all parties. Insofar as qualitative arms control has a role to play, it behooves us to understand the special requirements for achieving satisfactory agreements. The case of laser weapons allows us to explicate these requirements in a convenient and current context.

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